APPENDIX 1: BIORETENTION PLANT LIST

The following table includes both native and non-native plant species commonly available in the Puget Sound region and suitable for bioretention cell and swale applications. Individual site characteristics and goals may exclude some species or require modifications or additions to plant suggestions provided here.

Bioretention cells and swales generally feature three planting zones characterized by soil moisture and periodic inundation during the growing season.

Zone 1: Area of periodic or frequent standing or flowing water. Many Zone 1 plants will also tolerate the seasonally dry periods of summer in the Northwest without extra watering and may also be applicable in Zone 2 or 3.

Zone 2: Periodically moist or saturated during larger storms. Plants listed under Zone 2 will also be applicable in Zone 3.

Zone 3: Dry soils, infrequently subject to inundation or saturation. This area should blend with the existing landscape.

***** denotes native species

Special Considerations:

Drought tolerance – Several plants included on the list are not tolerant of dry conditions. When selecting these plants, it is important to consider that summer irrigation will be necessary.

Placement of large trees – consider height, spread and extent of roots at maturity. Use caution in plant selection for areas with under-drain pipes or other structures. If placed close to a road or driveway consider potential for lower limbs to cause visibility or safety problems. See Appendix 1: Street Trees for more information on tree selection and placement suggestions.

Phytoremediation – A list of plants that have been studied for their ability to filter, absorb and/or degrade specific contaminants is included in Appendix 5. While most of these plants are not included in the list below, varieties of some of the species known for phytoremediation are listed.

ZONE 1

TREES SPECIES/ COMMON NAME	EXPOSURE	MATURE SIZE/ SPREAD	TIME OF BLOOM	COMMENTS
*Alnus rubra** Red alder	Sun/partial shade	30-120 feet/ 25 ft. spread		Prefers moist, rich soils, highly adaptable, drought-tolerant; nitrogen fixer; rapid growing, relatively short-lived (60-90 years)
*Salix lucida** Pacific willow	Sun	40-60 feet/ 30 ft. spread		Wet soils; tolerates seasonal flooding; should not be planted in areas near pavement or underground structures
*Fraxinus latifolia** Oregon ash	Sun/partial shade	40-80 feet/ 30 ft. spread		Moist, saturated or ponded soils; flood tolerant; small green-white flowers
*Malus fusca** Pacific crabapple	Sun/partial shade	To 40 feet/ 35 ft. spread	Spring	Tolerant of prolonged soil saturation; produces fruit (do not plant near public walkways)

SHRUBS SPECIES/ COMMON NAME	EXPOSURE	MATURE SIZE	TIME OF BLOOM	COMMENTS
*Cornus sericea** Red-osier dogwood Red-twig dogwood	Sun/partial shade	To 15 feet	May - June	Prefers wet to moist organically rich soils, but is adaptable; tolerates seasonal flooding; small white flowers; berrylike fruits
Cornus sericea 'Kelseyi' Dwarf dogwood	Sun	To 1.5 feet	June – August	Prefers wet to moist organically rich soils, but is adaptable; small white flowers; berrylike fruit; compact, low growing, compact form; good ground cover
Cornus sericea 'Flaviramea' Yellow dogwood	Sun/partial shade	6-8 feet	May - June	Prefers wet to moist organically rich soils, but is adaptable; easily transplanted and grown; small, white flowers; yellow stems and reddish, purple fall color
Cornus sericea 'Isanti' Isanti dogwood	Sun/partial shade	4-5 feet	May - June	Prefers wet to moist organically rich soils, but is adaptable; deciduous shrub; tiny white flowers; red stems; purple fall color

ZONE 1

SHRUBS SPECIES/ COMMON NAME	EXPOSURE	MATURE SIZE	TIME OF BLOOM	COMMENTS
*Lonicera involucrata** Black twinberry	Partial shade/shade	2-8 feet	April - May	Moist soils; prefers loamy soils; tolerant of shallow flooding; yellow, tubular flowers attract hummingbirds
*Myrica californica** Pacific wax myrtle	Sun/partial shade	To 30 feet	May - June	Evergreen shrub preferring moist soils; inconspicuous spring flowers; drought-tolerant; if drought tolerance is not an issue try the smaller Washington native, *Myrica gale**
*Physocarpus capitatus** Pacific ninebark	Sun/partial shade	6-13 feet	May - June	Moist or dry soils; drought-tolerant; "snowball" shaped shrub; white flowers; seeds persist into winter
*Rosa pisocarpa** Clustered wild rose	Sun/partial shade	6-8 feet	May - July	Moist soils, tolerates seasonal flooding but also tolerant of dry conditions; pink clustered flowers; fruits persist
Salix purpunea 'Nana' Dwarf Artic willow	Sun/partial shade	3-5 feet		Grows well in poor soils; moderately drought-tolerant; small yellow flowers in the fall
*Spiraea douglasii** Douglas spirea Steeplebush	Sun/partial shade	4-7 feet		Moist or dry, to seasonally inundated soils; spikes of small, pink flower clusters

ZONE 1

EMERGENTS SPECIES/ COMMON NAME	EXPOSURE	MATURE SIZE	TIME OF BLOOM	COMMENTS
*Carex obnupta** Slough sedge	Sun/partial shade	1-5 feet		Moist to seasonally saturated soils; shiny foliage; excellent soil binder; drought-tolerant
*Carex stipata** Sawbeak sedge	Partial shade	10 inches - 3 feet		Wet soils; excellent soil binder
*Juncus effusus** Common rush	Sun/partial shade	1-2 feet	Summer	Wet soils; evergreen perennial; hardy and adaptable; drought-tolerant; small, non-showy flowers
*Juncus ensifolius** Daggerleaf rush	Sun	12-18 inches		Wet soils; shallow water; excellent soil binder
*Juncus tenuis** Slender rush	Sun	.5 – 2.5 feet		Moist soils; tufted perennial
*Scirpus acutus** Hardstem bulrush	Sun	4-8 feet		Wet soils; favors prolonged inundation; excellent soil binder
*Scirpus microcarpus** Small-fruited bulrush	Sun/shade	2-4 feet		Wet soils; tolerates prolonged inundation; good soil binder; drought-tolerant

ZONE 2

TREES SPECIES/ COMMON NAME	EXPOSURE	MATURE SIZE	TIME OF BLOOM	COMMENTS
Acer truncatum Pacific sunset maple	Sun	To 25 feet/ 20 ft. spread		Prefers moist, well-drained soils, but drought-tolerant; very cold hardy; deciduous tree with moderate growth rate
*Amelanchier alnifolia** Western serviceberry	Sun/partial shade	10-20 feet/ 25 ft. spread	April - May	Moist to dry, well-drained soils; drought-tolerant; large white flowers; purple to black berries; deciduous
*Corylus cornuta** Beaked hazelnut	Sun/partial shade	20 – 30 feet/ 15 ft. spread	April - May	Moist, well-drained soils; edible nuts; intolerant of saturated soils; catkins throughout winter add interest; deciduous
*Crataegus douglasii** Black hawthorn	Sun/partial shade	3-30 feet/ 25 ft. spread	Spring	Moist to dry, well drained, gravelly soils; small white flowers, black berries; 1" spines; forms thickets; deciduous
Fraxinus oxycarpa Raywood ash	Sun	25-50 feet/ 25 ft. spread	Spring	Drought-tolerant; grows in varying soil types; deciduous; can take extreme temperatures; does not tolerate constant wind or fog; resists pests and disease better than do non-native ashes; inconspicuous flowers
*Rhamnus purshiana** Cascara sagrada	Sun/shade	20-40 feet/ 25 ft. spread		Moist to fairly dry soils; small greenish-yellow flowers; deciduous; sensitive to air pollution; yellow fall color
*Salix scouleriana** Scouler willow	Sun/partial shade	6-40 feet/ 15 ft. spread		Moist to dry soils; drought-tolerant; deciduous tree; do not plant near paved surfaces or underground structures
*Salix sitchensis** Sitka willow	Sun/partial shade	3-26 feet/ 25 ft. spread		Moist soils; tolerates seasonal flooding; deciduous tree; do not plant near paved surfaces or underground structures
*Thuja plicata** Western red cedar	Partial shade/shade	200 feet+/ 60 ft. spread		Moist to swampy soils; tolerates seasonal flooding and saturated soils; long-lived; prefers shade while young

ZONE 2

SHRUBS - Deciduous SPECIES/ COMMON NAME	**EXPOSURE**	**MATURE SIZE**	**TIME OF BLOOM**	**COMMENTS**
*Acer circinatum** Vine maple	Filtered sun/shade	To 25 feet	Spring	Dry to moist soils; tolerant of shade and clay soils; excellent soil binder; beautiful fall color
Hamamelis intermedia Diane Diane witchhazel	Sun/partial shade	10-20 feet/ 10 ft. spread	January - March	Moist, fertile, acidic soil; showy fall color – yellow to yellow-orange; long-lasting, slightly fragrant, coppery-red flowers; not drought-tolerant; may require watering in dry season
*Oemleria cerasiformis** Indian plum/Osoberry	Sun/partial shade	5-16 feet	February - March	Moist to dry soils; prefers shade; tolerates fluctuating water table
Philadelphus x lemoinei 'Belle Etoile' Mock-orange	Sun/partial shade	5-6 feet	May - June	Prefers moist, well-drained soils, high in organic matter, but soil and pH adaptable; easily transplanted and established; fragrant, large white flowers, tinged red at the base; other cultivars available
*Ribes lacustre** Black swamp gooseberry	Partial shade	1.5 – 3 feet		Moist soils; deciduous shrub; reddish flowers in drooping clusters; dark purple berries; *R. divaricatum** (Wild gooseberry) grows to 5 feet and is also an option; attracts butterflies, but is very thorny
*Rosa nutkana** Nootka rose	Sun/partial shade	6-10 feet	April - June	Moist to fairly dry soils; tolerates inundation and saturated soils; aggressive spreader; fruits persist; less thorny that *R. rugosa*
Rosa rugosa (mixed varieties)	Sun	To 8 feet		Drought resistant; hardy, vigorous and aggressive; highly prickly; fragrant white to purple flowers; fruits persist
*Rubus parviflorus** Thimbleberry	Sun/partial shade	4-10 feet	May - June	Moist to dry soils; white flowers; red berries; makes thickets and spreads easily
*Rubus spectabilis** Salmonberry	Partial sun/shade	5-10 feet	February - April	Prefers moist, wet soils; good soil binder; magenta flowers; yellow/orange fruit; early nectar source for hummingbirds; makes thickets

ZONE 2

SHRUBS-Deciduous SPECIES/ COMMON NAME	**EXPOSURE**	**MATURE SIZE**	**TIME OF BLOOM**	**COMMENTS**
*Sambucus racemosa** Red elderberry	Partial sun/partial shade	To 20 feet	April - May	Moist to dry soils; small white flowers; bright red berries; vase shaped; pithy stems lead to "messy" form – prune for tidiness
*Symphoricarpos albus** Snowberry	Sun/partial shade	2-6 feet		Wet to dry soils, clay to sand; excellent soil binder; drought and urban air tolerant; provides good erosion control; spreads well in sun; white berries; flowers attract hummingbirds
*Vaccinium parvifolium** Red huckleberry	Partial shade/shade	4-10 feet		Slightly moist to dry soils; prefers loamy, acid soils or rotting wood; tolerant of dry, shaded conditions; red fruit; tricky to transplant

HERBACEOUS SPECIES/ COMMON NAME	**EXPOSURE**	**MATURE SIZE**	**TIME OF BLOOM**	**COMMENTS**
*Aquilegia formosa** Western columbine	Sun/partial shade	1-3 feet	Spring	Moist soils of varying quality; tolerant of seasonal flooding; red and yellow flowers attract hummingbirds and butterflies
*Asarum caudatum** Wild ginger	Partial shade/shade	To 10 inches	Mid spring	Moist organic soils; heart-shaped leaves; reddish-brown flowers
*Aster chilensis** Common California aster	Sun	1.5 – 3 feet	June - September	Moist soils; white to purple flowers
*Aster subspicatus** Douglas' aster	Sun	.5 – 2.5 feet	June - September	Moist soils; blue to purple flowers
*Camassia quamash** Common camas	Sun/partial shade	To 2.5 feet	May - June	Moist to dry soils; lots of watering needed to establish; loose clusters of deep blue flowers

ZONE 2

HERBACEOUS SPECIES/ COMMON NAME	EXPOSURE	MATURE SIZE	TIME OF BLOOM	COMMENTS
Camassia leichtlinii Giant camas		2 –4 feet	May - June	Moist to dry soils; lots of watering to establish; large clusters of white, blue or greenish-yellow flowers
*Iris douglasiana** Pacific coast iris	Sun/partial shade	1-2 feet	Spring	Tolerates many soils; withstands summer drought and seasonal flooding; white, yellow, blue, reddish purple flowers; fast growing; velvety purple flowers; vigorous
Iris foetidissima Gladwin iris	Sun/partial shade	1-2 feet	May	Moist to dry, well-drained soils; pale lilac flower; also called Stinking Iris
*Juncus tenuis** Slender rush	Sun	6 inches – 2.5 feet		Moist soils; yellow flowers
Iris sibirca Siberian Iris	Sun	1-2.5 feet	Late spring – early summer	Moist soils; deep blue, purple to white flowers
*Tellima grandiflora** Fringecup	Partial sun/shade	1-3 feet	March - June	Perennial preferring moist soils; yellowish-green to pink flowers
*Tiarella trifoliata** Foamflower	Partial sun/shade	To 1 foot	Early - mid summer	Moist soils; perennial with some drought tolerance after established; can form dense colonies; white flowers
*Tolmiea menziesii** Youth-on-age/Piggy-back plant	Partial shade/shade	1-2 feet	April - August	Moist soils; brownish-purple flowers; also makes and effective ground cover
Viola species* Violets	Partial shade/shade	6 - 12 inches	Late spring – early summer	Moist soils; yellow to blue flowers

ZONE 3

TREES SPECIES/ COMMON NAME	EXPOSURE	MATURE SIZE	TIME OF BLOOM	COMMENTS
Cornus spp. Dogwood	Sun/partial shade	20-30 feet/ 30 ft. spread	May	Reliable flowering trees with attractive foliage and flowers; may need watering in dry season; try *C. florida* (Eastern dogwood), or *C. nuttallii** (Pacific dogwood) or hybrid 'Eddie's White Wonder'. Also, *C. kousa* for small tree/shrub which is resistant to anthracnose
*Prunus emarginata** Bitter cherry	Sun/partial shade	20-50 feet/ 20 ft. spread	May - June	Dry or moist soils; intolerant of full shade; purple to black cherries; bright fruits are attractive to birds; roots spread extensively
Prunus virginiana Choke cherry		3-25 feet/ 15-20 ft. spread	Late spring – Early summer	Dry or moist soils; deep rooting; attractive white fragrant flowers; good fall color
*Pseudotsuga menziesii** Douglas-fir	Sun	100-250 feet/ 50-60 ft. spread		Does best in deep, moist soils; evergreen conifer with medium to fast rate of growth; provides a nice canopy, but potential height will restrict placement
*Quercus garryana** Oregon white oak	Sun	To 75 feet		Dry to moist, well-drained soils; slow growing; acorns

ZONE 3

TREES - Evergreen SPECIES/ COMMON NAME	EXPOSURE	MATURE SIZE	TIME OF BLOOM	COMMENTS
Arbutus unedo Strawberry tree	Sun/partial shade	8-35 feet/ 8-20 ft. spread	November - December	Tolerant of extremes; tolerant of urban/industrial pollution; white or greenish white flowers
*Calocedrus decurrens** Incense cedar	Sun	75-90 feet/ 12 ft. spread		Tolerant of poor soils; drought-tolerant after established; fragrant evergreen with a narrow growth habit; slow growing
Chamaecyparis obtusa Hinoki false cypress	Sun/partial shade	40-50 feet/ 15-30 ft. spread		Moist, loamy, well-drained soils; very slow growing; prefers sun, but tolerates shade; does not transplant well or do well in alkaline soils. Note there are many alternative varieties of false cypress of varying sizes and forms from which to choose.
Pinus mugo Swiss mountain pine	Sun/partial shade	15-20 feet/ 25-30 ft. spread		Prefers moist well-drained soil; slow growing, broadly spreading, bushy tree; hardy evergreen
Pinus thunbergiana Japanese black pine	Sun	To 100 feet/ 40 ft. spread		Dry to moist soils; hardy; fast growing

SHRUBS SPECIES/ COMMON NAME	EXPOSURE	MATURE SIZE	TIME OF BLOOM	COMMENTS
*Holodiscus discolor** Oceanspray	Sun/partial shade	To 15 feet	June - July	Dry to moist soils; drought-tolerant; white to cream flowers; good soil binder
*Philadelphus lewisii** Mock-orange	Sun/partial shade	5-10 feet	June - July	Adapts to rich moist soils or dry rocky soils; drought-tolerant; fragrant flowers

ZONE 3

SHRUBS SPECIES/ COMMON NAME	EXPOSURE	MATURE SIZE	TIME OF BLOOM	COMMENTS
Pinus mugo pumilio Mugho pine	Sun	3-5 feet/ 4-6 ft. spread		Adapts to most soils; slow growing and very hardy; newer additions with trademark names such as 'Slo-Grow' or 'Lo-Mound' are also available
Potentilla fruticosa Shrubby cinquefoil	Sun	To 4 feet	May - September	Moist to dry soils; several cultivars available with varying foliage and flower hues; try 'Tangerine' or 'Moonlight'
*Potentilla gracilis** Graceful cinquefoil	Sun	1-2 feet	July	Moist to dry soils; yellow flowers
*Ribes sanguineum** Red-flowering currant	Sun/partial shade	8-12 feet	March – April	Prefers dry soils; drought-tolerant; white to deep-red flowers attract hummingbirds; dark-blue to black berries; thornless
*Rosa gymnocarpa** Baldhip rose	Partial shade	To 6 feet	May - July	Dry or moist soils; drought-tolerant; small pink to rose flowers

SHRUBS-Evergreen SPECIES/ COMMON NAME	EXPOSURE	MATURE SIZE	TIME OF BLOOM	COMMENTS
Abelia x grandiflora Glossy abelia	Partial Sun/Partial shade	To 8 feet/ 5 foot spread	Summer	Prefers moist, well-drained soils, but drought-tolerant; white or faintly pink flowers
Arbutus unedo 'Compacta'	Sun/partial shade	To 10 feet	Fall	Prefers well drained soils; tolerant of poor soils; good in climate extremes; white to greenish-white flowers; striking red-orange fruit

ZONE 3

SHRUBS-Evergreen SPECIES/ COMMON NAME	**EXPOSURE**	**MATURE SIZE**	**TIME OF BLOOM**	**COMMENTS**
Cistus purpureus Orchid rockrose	Sun	To 4 feet	June - July	Moist to dry well-drained soils; drought resistant; fast growing; reddish purple flowers
Cistus salviifolius White rockrose	Sun	2-3 feet/ 6 ft spread	Late spring	Moist to dry well-drained soils preferred, but can tolerate poor soils; tolerant of windy conditions and drought; white flowers
Escallonia x exoniensis 'fradesii' Pink princess	Sun/partial sun	5-6 feet	Spring - Fall	Tolerant of varying soils; drought-tolerant when established; pink to rose colored flowers; good hedge or border plant; attracts butterflies
Osmanthus delavayi Delavay Osmanthus	Sun/partial shade	4-6 feet	March-May	Tolerant of a broad range of soils; attractive foliage and clusters of white fragrant flowers; slow growing
Osmanthus x burkwoodii Devil wood	Sun/partial shade	4-6 feet	March-April	Drought-tolerant once established; masses of small, white fragrant flowers
Rhododendron 'PJM' hybrids	Sun/partial shade	To 4 feet	Mid – late April	Moist to fairly dry soils; well drained organic soil; lavender to pink flowers
Stranvaesia davidiana	Sun	6-20 feet	June	Moist soils; white flowers in clusters; showy red berries
Stranvaesia davidiana undulata	Sun	To 5 feet	June	Moist soils; lower growing irregularly shaped shrub; great screening plant
*Vaccinium ovatum** Evergreen huckleberry	Partial shade	3-15 feet	March	Moist to slightly dry soils; small pinkish-white flowers; berries in August

ZONE 3

GROUND COVER - Evergreen SPECIES/ COMMON NAME	**EXPOSURE**	**MATURE SIZE**	**TIME OF BLOOM**	**COMMENTS**
*Arctostaphylos uva-ursi** Kinnik kinnik	Sun/partial shade		April - June	Prefers sandy/rocky, well-drained soils; flowers pinkish-white; bright red berries; slow to establish; plant closely for good results
*Gaultheria shallon** Salal	Partial shade/shade	3-7 feet	March - June	Dry and moist soils; white or pinkish flowers; reddish-blue to dark-purple fruit
*Fragaria chiloensis** Wild/Coastal strawberry	Sun/partial shade	10 inches	Spring	Sandy well drained soils; flowers white; small hairy strawberries; evergreen; aggressive spreader
Helianthemum nummularium Sunrose	Sun	To 2 feet/ 2 ft. spread	May - July	Prefers moist, well-drained soils, but will tolerate various soils; low-growing, woody perennial; many varieties are available with flowers in salmon, pink, red, yellow and golden colors.
Lavandula angustifolia Lavender	Sun/partial shade	To 1.5 feet	June-August	Adaptable to various soils; blue, lavender, pink to white flowers, semi-evergreen aromatic perennial
*Mahonia nervosa** Cascade Oregon grape/Dull Oregon grape	Partial shade/shade	To 2 feet	April – June	Dry to moist soils; drought resistant; evergreen; yellow flowers; blue berries
Mahonia repens Creeping mahonia	Sun/partial shade	3 feet	April - June	Dry to moist soils; drought resistant; yellow flowers; blue berries; native of Eastern Washington
*Penstemon davidsonii** Davidson's penstemon	Sun	To 3 inches	June - August	Low growing evergreen perennial; prefers well-drained soils; drought-tolerant; blue to purple flowers

ZONE 3

PERENNIALS & ORNAMENTAL GRASSES SPECIES/ COMMON NAME	**EXPOSURE**	**MATURE SIZE**	**TIME OF BLOOM**	**COMMENTS**
*Achillea millefolium** Western yarrow	Sun	4 inches – 2.5 feet	June - September	Dry to moist, well-drained soils; white to pink/reddish flowers; many other yarrows are also available
Anaphalis margaritaceae Pearly everlasting	Sun/partial shade	To 18 inches		Drought-tolerant perennial; spreads quickly; attracts butterflies
*Bromus carinatus** Native California brome	Sun/partial shade	3-5 feet		Dry to moist soils; tolerates seasonal saturation
Carex buchanaii Leather leaf sedge	Sun/partial shade	1-3 feet		Prefers moist, well-drained soils; copper-colored foliage; perennial clumping grass; tolerant of a wide range of soils; inconspicuous flowers
Carex comans 'Frosty curls' New Zealand hair sedge	Sun/partial shade	1-2 feet	June - August	Prefers moist soils; finely textured and light green; compact, clumping perennial grass; drought-tolerant when established; inconspicuous flowers
Coreopsis spp.	Sun	1-3 feet		Dry to moist soils; drought-tolerant; seeds attract birds; annual and perennial varieties; excellent cut flowers
Echinacea purpurea Purple coneflower	Sun	4-5 feet		Prefers well drained soils; hardy perennial; may need watering in dry months
*Elymus glaucus** Blue wildrye	Sun/partial shade	1.5-5 feet		Dry to moist soils; shade tolerant; rapid developing, but short lived (1-3 years); not good lawn grass
*Dicentra formosa** Pacific bleeding-heart	Sun/shade	6-20 inches	Early spring - early summer	Moist, rich soils; heart-shaped flowers
*Erigeron speciosus** Showy fleabane	Sun/partial shade	To 2 feet	Summer	Moist to dry soils; dark violet or lavender blooms; fibrous roots

ZONE 3

PERENNIALS & ORNAMENTAL GRASSES SPECIES/ COMMON NAME	**EXPOSURE**	**MATURE SIZE**	**TIME OF BLOOM**	**COMMENTS**
Festuca ovina 'Glauca' Blue fescue	Sun/partial shade	To 10 inches	May - June	Prefers moist, well-drained soils; blue-green evergreen grass; drought-tolerant; shearing will stimulate new growth
*Festuca idahoensis** Idaho fescue	Sun/partial shade	To 1 foot		Bluish-green bunching perennial grass; drought-tolerant
*Fragaria vesca** Wood strawberry	Partial shade	To 10 inches	Late spring - early summer	Dry to moist soils; white flowers
*Gaultheria shallon** Salal	Sun/shade	3-7 feet	March - June	Dry and moist soils; white or pinkish flowers; reddish-blue to dark-purple fruit
Gaura lindheimeri Gaura	Sun	2.5-4 feet		Perennial; fairly drought-tolerant and adaptable to varying soil types; long blooming period
*Geum macrophyllum** Large-leaved avens	Sun/partial shade	To 3 feet	Spring	Moist, well-drained soil; bright yellow flowers; other *Geum* cultivars available, some which may require supplemental watering
Geranium maculatum Spotted geranium	Sun/shade	To 1.5 feet	July	Moist, well-drained soils; low perennial; pale pink, blue to purple flowers
Geranium sanguineum Cranesbill	Sun/partial shade	To 1.5 feet	May - August	Moist soils; deep purple almost crimson flowers
Helichrysum italicum Curry Plant	Sun	To 2 feet	Summer	Moist or dry soils; hardy evergreen perennial; a good companion to lavender; bright yellow flowers; fragrant
Helictotrichon sempervirens Blue oat grass	Sun/partial shade	1-1.5 feet	June - August	Tolerant of a variety of soil types but prefers well-drained soil; clumping bright blue evergreen grass; bluish white flowers

ZONE 3

PERENNIALS & ORNAMENTAL GRASSES SPECIES/ COMMON NAME	**EXPOSURE**	**MATURE SIZE**	**TIME OF BLOOM**	**COMMENTS**
Hemerocallis fulva Day lilies	Sun/partial shade	1-4 feet	Summer	Tolerant of a variety of soil types; easy to grow and tolerant of neglect; hardy perennial; entire plant is edible
Heuchera americana Coral bells (alumroot)	Sun/partial shade	1-2 feet	June - August	Moist to dry, well-drained soils; never wet; easily transplantable perennial; red, greenish-white flowers; may need supplemental watering in dry season
Heuchera micrantha 'Palace purple' (alumroot)	Sun/partial shade	1-2 feet	June - August	Moist, well-drained soils; bronze to purple foliage in shade; small, yellowish-white flowers; perennial, evergreen; a number of other species and varieties are available. Try *H. sanguinea* for bright red flowers.
*Lupinus** Lupines	Sun	3-5 feet	March - September	Moist to dry soils; various native varieties; blue to purple, violet to white flowers; both native and non-native varieties
*Lupinus bicolor** Two-color lupine	Sun	4 inches-1.5 feet	Spring	Dry gravelly soils; small-flowered; annual
*Lupinus latifolius** Broadleaf lupine	Sun	To 1 foot	June - August	Dry to moist soils; perennial; bushy herb; bluish flowers
*Lupinus polyphyllus** Large-leafed lupine	Sun	To 3 feet	Spring - summer	Dry to moist, sandy to gravelly soils; perennial
*Mahonia aquifolium** Tall Oregon grape	Sun/partial shade	6-10 feet	March - April	Dry to moist soils; drought resistant; evergreen; blue-black fruit; bright yellow flowers; 'Compacta' form averages 2 feet tall; great low screening barrier
*Maianthemum dilatatum** False lily-of-the-valley	Partial shade/shade	3-12 inches	Spring	Prefers moist soils; small, white flowers; light-green to red berries

ZONE 3

PERENNIALS & ORNAMENTAL GRASSES SPECIES/ COMMON NAME	EXPOSURE	MATURE SIZE	TIME OF BLOOM	COMMENTS
Pennisetum alopecuroides Fountain grass	Sun/partial shade	1-2 feet	August - September	Moist, well-drained soils; tolerant of many soil types; clump forming grasses. A number of varieties are available in different heights and bloom times. Try *P. caudatum* (White-flowering fountain grass) and *P. alopecuroides* cultivars 'Hameln' and 'Little bunny' (Dwarf fountain grass).
Pennisetum orientale Oriental fountain grass	Sun/partial shade	1-3 feet	June-October	Prefers moist, well-drained soils; somewhat drought-tolerant; small clumping, blooming grass, showy pink flowers; fountain grasses will benefit from annual shearing in late winter/early spring, but not required.
Penstemon fruticosus Bush penstemon	Sun	8 –10 inches	May	Prefers well-drained soils; evergreen perennial; drought-tolerant; violet-blue flowers 1" long attract hummingbirds
*Polystichum munitum** Swordfern	Partial shade/ Deep shade	2-4 feet		Prefers moist, rich soil conditions, but drought-tolerant; large evergreen fern
Rudbeckia hirta Black-eyed susan	Sun/partial shade	3-4 feet	Summer	Moist to dry soils; showy flowers, hardy and easy to grow; several other varieties are available
*Smilacina racemosa** False Solomon's seal	Partial sun/shade	1-3 feet	April - May	Moist soils; creamy white flowers; red berries
*Solidago canadensis** Canadian goldenrod	Sun/partial shade	1-2 feet	Late summer - early fall	Dry to moist soils; yellow flowers

BOG GARDEN PLANTS

A bog garden presents a unique design option for managing stormwater on site. A lined depression featuring an organic soil mix and wetland vegetation can be an attractive method of promoting evaporation and transpiration of collected runoff. A functioning bog garden generally displays no standing water, but soils are saturated much of the time necessitating facultative wetland plant selections.

To select plant species appropriate for a bog garden refer to those listed in **Appendix 3 (BIORETENTION PLANT LIST)** – **Zone 1** as well as those found in following table. The list below includes native and non-native plant species (not listed in the Bioretention Plant List) that have been successfully applied in a Pacific Northwest bog garden setting. It may be necessary to provide additional water to the bog system during seasonal dry periods due to a lack of stormwater runoff.

As with any system, plant species in a bog garden setting have various preferences for moisture and sun. Check listed comments below and research plant needs to optimize successful growth in the conditions specific to individual bog garden systems.

Bog Garden SPECIES/ COMMON NAME	**EXPOSURE**	**MATURE SIZE**	**TIME OF BLOOM**	**COMMENTS**
*Adiantum aleuticum** Western maidenhair fern	Shade/partial shade	1-2 feet		Moist to wet soils; graceful, delicate fern; vivid bright green with black stems; spreads through creeping rhizomes; often called *A. pedatum*, but this refers to the related East Coast maidenhair fern; also try *A. capillis-veneris* (Venus-hair fern)
*Andromeda polifolia** Bog rosemary	Sun/partial shade	1-1.5 feet	Spring	Moist to wet soils; low-growing evergreen shrub; white to pink flower clusters; ornamental varieties include 'Blue Ice', 'Grandiflora' and 'Nana'
*Blechnum spicant** Deer fern	Shade/partial shade	1-3 feet		Moist to wet soils; has both evergreen and deciduous leaves; prefers soils high in organic material; is sensitive to frost

Bog Garden SPECIES/ COMMON NAME	**EXPOSURE**	**MATURE SIZE**	**TIME OF BLOOM**	**COMMENTS**
Carex ssp. Sedges	Sun/shade	varies		A number sedge choices are great options for a bog garden setting; two are listed in **Appendix 3 – Zone 1**, but there are many alternative species to investigate, including *Carex mertensii** (Mertens' sedge) and *C. lyngbyei** (Lyngby's sedge)
*Cornus sericea** Red-osier dogwood Red-twig dogwood	Sun/partial shade	To 15 feet		Prefers wet to moist organically rich soils, but is adaptable; tolerates seasonal flooding; multi-stemmed, deciduous shrub with red fall color; small white flowers; bluish-white berries in the fall; see **Appendix 3 – Zone 1** listing for additional cultivars
*Eleocharis palustris** Creeping spike-rush	Sun	To 3.5 feet		Wet soils to shallow water; perennial forming small clumps
*Empetrum nigrum** Crowberry	Sun	To 8 inches	Early spring	Dry to wet/boggy soils; low-growing evergreen shrub; small purplish flowers and purplish-black berries
*Equisetum hyemale** Scouring-rush	Sun/partial shade	2-5 feet		Moist to wet soils; hollow-stemmed, evergreen perennial; spreads through creeping rhizomes; vigorous and persistent; with high silica content; also *E. scirpoides* (Dwarf horsetail); use both with caution – *Equisetum* can be very invasive and difficult to remove once established
*Gaultheria ovatifolia** Oregon wintergreen/ Western teaberry	Partial shade	To 1 foot	Late spring - summer	Moist to wet soils; low-growing evergreen shrub; pink or whitish flowers and red berries; also *G. humifusa** (Alpine wintergreen)
*Glyceria elata** Tall mannagrass	Sun/partial shade	3-4.5 feet		Moist to wet soils; loosely tufted perennial, spreads through creeping rhizomes; also try the taller *G. grandis** (Reed mannagrass)
Gunnera manicata Gunnera	Sun/partial shade	4-6 feet/ 4-8 ft. spread		Moist to wet organic soils; prefers humid setting; non-native from Brazil and Columbia needing mulching protection in the winter; also referred to as 'giant rhubarb'; huge rounded leaves; needs plenty of space; also *G. tinctoria* from Chile

Bog Garden SPECIES/ COMMON NAME	**EXPOSURE**	**MATURE SIZE**	**TIME OF BLOOM**	**COMMENTS**
Hakonechloa macra Japanese forest grass	Shade/partial shade	1-3 feet		Prefers moist, rich soil; slowly spreading perennial grass; green leaves turn coppery orange in the fall
Hosta Plantain lily	Shade/partial sun	To 2.5 feet	Summer	Prefer moist, rich soil; many varieties and hybrids available in a various sizes, foliage textures and colors; thin spikes of blue or white flowers; some are tolerant of sun, but most prefer shade
Juncus ssp. Rushes	Sun/shade	varies		As with the *Carex* species, there are a number of native rushes that would work well in a bog garden. Three options are listed in **Appendix 3 – Zone 1**; others to investigate include *Juncus mertensianus** (Mertens' rush) and *J. acuminatus** (Tapered rush)
*Kalmia occidentalis** Swamp-laurel	Sun	.5-2 feet	Spring- early summer	Also known as *K. polifolia,* prefers moist soils; low shrub with aromatic leaves; rose-purple flowers; also try *K. microphylla** (Western bog-laurel) a mat-forming, evergreen shrublet; generally found in wet subalpine conditions
*Ledum groenlandicum** Labrador tea	Shade/partial sun	1.5 – 4.5 feet	Summer	Moist to boggy soils; evergreen shrub with small white flower clusters; foliage aromatic when crushed
Ligularia dentata Bigleaf ligularia	Shade/partial shade	3 – 5 feet	Summer	Moist to wet soils; large-leaved, clumping perennial; yellow-orange blooms; not tolerant of high heat or low humidity; try *L. dentata* cultivars 'Othello' and 'Desdemona'; also *L. przewalskii* (Shavalski's ligularia) and *L. stenocephala* (Narrow-spiked ligularia)
*Linnaea borealis** Twinflower	Shade/partial shade	4-6 inches	June-September	Moist or dry soils; evergreen perennial; pink, fragrant, trumpet-like flowers; trailing ground cover; try *L. borealis* on the less saturated margins of a bog garden; may be difficult to establish
Lobelia cardinalis Cardinal flower	Sun/partial shade	2-4 feet	Summer	Wet to moist, rich soils; clumping perennial; tubular, bright red, inch-long flowers; also try *L. siphilitica* (Blue lobelia), another perennial with blue flowers

Bog Garden SPECIES/ COMMON NAME	**EXPOSURE**	**MATURE SIZE**	**TIME OF BLOOM**	**COMMENTS**
*Lysichiton americanum** Skunk cabbage	Shade/partial shade	2-3 feet	March	Prefers wet soils; deciduous perennial; what some consider to be a skunky odor especially when blooming; yellow hooded fleshy flower spike; great leaves dominate
Matteuccia struthiopteris Ostrich fern	Sun/shade	To 6 feet		Moist, rich soils; hardy northern fern; clumping narrowly at base with foliage spreading to 3 feet in width
Mimulus ssp. Monkey-flower	Sun/partial shade	1-3 feet	Spring-summer	Wet soils; perennial or annual that reseeds nicely and keeps spreading; many species available including natives, *M. guttatus** (Yellow monkey-flower) and *M. tilingii** (Mountain monkey-flower); also *M. lewisii** with rose-red to pale-pink flowers
*Myrica gale** Sweet gale	Sun/partial shade	To 4 feet		Moist to wet soils; aromatic, deciduous perennial shrub; glossy green leaves; a nitrogen fixing species
Oplopanax horridum Devil's club	Shade/partial sun	3-10 feet		Moist to wet soils; forms extensive clumps; aggressive grower, but huge palmate leaves highly decorative; clusters of small whitish flowers; wand-like stems have sharp spines
Osmunda cinnamomea Cinnamon fern	Sun/partial shade	2-5 feet		Moist to wet soils; large deciduous fern; unfolding 'fiddlehead' fronds are edible
*Oxycoccus oxycoccos** Bog cranberry	Sun	4-16 inches		Moist to wet soils, prefers *Sphagnum* moss mats, peat and acidic conditions; evergreen, low-creeping vine like shrub; pink to red flowers; red berries; shade intolerant
*Polystichum munitum** Sword fern	Shade/partial shade	2-5 feet		Moist soils; large evergreen fern; dark green fronds with dagger shaped leaflets; hardy and easy to grow
*Potentilla palustris** Marsh cinquefoil		To 3 feet		Moist to wet soils; perennial with reddish-purple flowers; stems both prostrate and ascending

Bog Garden SPECIES/ COMMON NAME	**EXPOSURE**	**MATURE SIZE**	**TIME OF BLOOM**	**COMMENTS**
*Ribes divaricatum** Wild gooseberry	Partial shade/shade	1.5-6.5 feet		Prefers wet or moist soils; green or purple flowers and smooth, dark purple berries; a hedge or screen provides good habitat for birds and wildlife; beware prickly spines; also try *R. lacustre** (Black gooseberry)
*Salix arctica** Arctic willow	Sun/shade	To 2 feet	Spring	Moist soils; deciduous, prostrate or trailing shrub; leaves are dark green on the bottom and lighter on top; brownish to pink flowers; see **Appendix 3 – Zone 1** listing for details on *S. purpunea* 'Nana'
*Trientalis arctica** Northern starflower	Shade/partial shade	To 8 inches		Wet, boggy soils; small perennial; star-shaped white flowers, or with a pink tinge

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APPENDIX 3: LABORATORY PROCEDURES FOR DETERMINING BIORETENTION SOIL MIX SATURATED HYDRAULIC CONDUCTIVITY

The recommended permeability testing method for bioretention soil mixes (ASTM D2434 Standard Test Method for Permeability of Granular Soils) is a test developed for mineral aggregate material rather than soils that contain appreciable organics. Organic soils tend to swell when mixed with water and are sensitive to compaction, which can cause variability in test results. As a result, the City of Seattle identified a need for changes to the standard permeability testing procedures to provide more consistent and reliable results. Aspect Consulting, LLC was retained to conduct two workshops with local soil testing laboratories, have each of the laboratories conduct permeability testing, and develop recommendations for modifications to the standard permeability testing procedures that would provide more consistent results. The following provides recommendations for revisions to the standard permeability testing procedures based on the workshops and laboratory testing.

Recommended Modifications for Permeability Testing of Bioretention Soils

Proctor method ASTM D1557 Method C (6-inch mold) shall be used to determine maximum dry density values for compaction of bioretention soil sample. Sample preparation for the Proctor test shall be amended in the following ways:

1. Maximum grain size within the sample shall be no more than ½ inches in size.
2. Snip larger organic particles (if present) into ½ inch long pieces.
3. When adding water to the sample during the Proctor test, allow the sample to pre-soak for at least 48 hours to allow the organics to fully saturate before compacting the sample. This presoak ensures the organics have been fully saturated at the time of the test.

ASTM D2434 shall be used and amended in the following ways:

4. Apparatus:
    a. 6-inch mold size shall be used for the test.
    b. If using porous stone disks for the testing, the permeability of the stone disk shall be measured before and after the soil tests to ensure clogging or decreased permeability has not occurred during testing.
    c. Use the confined testing method, with 5- to 10-pound force spring
    d. Use de-aired water.

5. Sample:
    a. Maximum grain size within the sample shall not be more than ½ inches in size.
    b. Snip larger organic particles (if present) into ½-inch long pieces.
    c. Pre-soak the sample for at least 48 hours prior to loading it into the mold. During the pre-soak, the moisture content shall be higher than optimum moisture but less than full saturation (i.e., there shall be no free water). This pre-soak ensures the organics have been fully saturated at the time of the test.
6. Preparation of Sample:
    a. Place soil in cylinder via a scoop.
    b. Place soil in 1-inch lifts and compact using a 2-inch-diameter round tamper. Pre-weigh how much soil is necessary to fill 1-inch lift at 85% of maximum dry density, then tamp to 1-inch thickness. Once mold is full, verify that density is at 85% of maximum dry density (+ or – 0.5%). Apply vacuum (20 inches Hg) for 15 minutes before inundation.
    c. Inundate sample slowly under a vacuum of 20 inches Hg over a period of 60 to 75 minutes.
    d. Slowly remove vacuum (> 15 seconds).
    e. Sample shall be soaked in the mold for 24 to 72 hours before starting test.
7. Procedure:
    a. The permeability test shall be conducted over a range of hydraulic gradients between 0.1 and 2.
    b. Steady state flow rates shall be documented for four consecutive measurements before increasing the head.
    c. The permeability test shall be completed within one day (one-day test duration).

APPENDIX 4: MAINTENANCE OF LOW IMPACT DEVELOPMENT FACILITIES

The following provides two maintenance guidelines. The first is a general maintenance approach that includes goals, objectives, support strategies, and responsibilities. The second is a more detailed maintenance manual for bioretention and permeable pavement developed by the City of Seattle. The manual covers soils, plants and hardscape infrastructure (e.g. catch basins and pipes) for bioretention, and inspection and maintenance for permeable pavement. Maintenance effort is based on levels of service acceptable for the location of the facilities and the jurisdiction. An additional maintenance manual, developed by the City of Bellevue, is available at: http://www.bellevuewa.gov/pdf/Utilities/Natural_Drainage_Practices.pdf.

A. Introduction

The maintenance of LID facilities is essential to ensure that designed stormwater management performance and other benefits continue over the full life cycle of the installation. Some of the maintenance agreements and activities associated with LID practices are similar to those performed for conventional stormwater systems; however, the scale, location, and the nature of an LID approach will also require new maintenance strategies. The following outlines typical maintenance goals and objectives, types of maintenance agreements, and training (WSU, AHBL, PSAT, 2007).

1. Goals and Objectives

Many maintenance goals of LID facilities will be similar throughout the Puget Sound region. The following provides a standard set of goals that can be added to or modified according to the specific physical settings and needs of a local jurisdiction.

A. Flow Control and Drainage
   - Maintain pre-development infiltration capacity (reduce total volume of surface flows) and flow attenuation of facility.
   - Maintain pre-development detention capability to reduce peak flows.
   - Safely convey design storm flows.

B. Water Quality Treatment
   - Maintain pre-development infiltration and detention capability.

- Preserve soil and plant health and contact of storm flows with those plant soil systems.

C. Safety and Emergency Vehicle Access
   - Maintain adequate sight distances.
   - Create signage for emergency vehicle access and facilities.
   - Ensure the sufficient carrying capacity for emergency vehicles of any permeable load-bearing surfaces.

D. Cost Effectiveness
   - Maintain facilities for long-term, high quality performance at a cost that is equal to, or less than, conventional systems.
   - Prevent expensive repair of large scale or catastrophic problems through continued routine procedures.

E. Aesthetics
   - Develop LID facilities as a landscape amenity as well as a stormwater management system.

F. Public Health
   - Minimize potential for disease transmission and mosquito breeding by maintaining designed infiltration capacity, storm flow conveyance, ponding depths, and dewatering rates.

G. Community Participation
   - Provide educational materials to homeowners and commercial property owners explaining the benefits, function, and importance of community participation for the long-term performance of LID facilities.

2. Support Strategies

Effective measures to support and ensure quality maintenance of LID facilities include education, incentives, and regulations. In order to provide the most effective maintenance programs, a variety of strategies should be selected from the list below.

A. Education
   - Simple, concise messages delivered throughout the project life cycle.
   - Brochures explaining the functions, benefits, and responsibilities of facilities at transfer of deed.
   - Information bulletins over public access channels.

- Community volunteers providing informal workshops.
- Ongoing involvement of developer with community groups.
- Training programs for those maintaining the systems.

B. Incentives
   - Reduce stormwater utility fees for individual homeowners or commercial properties.
   - Provide support for property owners with technical advice and materials, such as mulch and plants.
   - Provide awards and recognition to innovative developers and communities that build and properly maintain LID facilities.

C. Regulations
   - Require maintenance plans and agreements prior to project approvals. These would include a list of all proposed facilities, facility locations, a schedule of maintenance procedures, monitoring requirements, if any, and an agreement that all subject properties are collectively liable for the ongoing maintenance of the facilities.
   - Mandate jurisdictional maintenance and additional taxes for funding.
   - Require fines for corrective actions.
   - State that maintenance responsibilities and liabilities are shared by all property owners for projects with facilities designed to serve multiple properties or owned and/or maintained collectively.
   - Require deed restrictions or covenants conveyed with deed for the full life cycle of all project types.

3. Maintenance Responsibilities

Low Impact Development facilities range in size and complexity. Accordingly, entities responsible for maintenance should be appropriately matched to the tasks required to ensure long-term performance. An individual homeowner may be able to reasonably maintain a rain garden, permeable driveway, or other small facility; however, larger facilities are often maintained through private parties, shared maintenance agreements or the presiding jurisdiction. In addition, the use and ownership of properties can often help dictate the most appropriate means of facility maintenance. Below are some general guidelines for the three primary categories of Maintenance Responsibilities.

A. Property Owners

- Are usually responsible for small facilities located on an individual property.
- Require basic knowledge and understanding of how the system functions.
- Jurisdiction(s) can improve system function over time by offering basic training to property owners.
- Should know when to seek and where to find technical assistance and any additional information.
- Requirements for maintenance should be conveyed with deed.
- Failure to properly maintain LID facilities may result in jurisdictional liens.

B. Private Parties

- Handle the widest range of LID projects in size and scope.
- Handle most commercial or multi-family properties. Copies of agreement may be required prior to project approval.
- Unique maintenance agreements should be developed based on the scale, use, and characteristics of the site and conservation areas, as well as level of expertise of the property owner and the responsible jurisdiction.
- Maintenance agreements can be between a variety of parties, such as individual homeowners, property owner associations, or even jurisdictions.
- Outside groups responsible for maintenance should be trained in the design, function, benefits, and maintenance of LID facilities.
- Recognize that integrated LID management practices require more frequent inspection than conventional facilities.
- Third-party maintainers should provide documentation to the property owners of the type of maintenance performed, a certificate of function, and any non-routine maintenance needs requiring specialized corrective actions.
- Jurisdictions may choose to provide an educational course for prospective maintenance parties and a list of approved or recommended parties.

C. Jurisdictions

- Will handle most public LID infrastructure.
- Should be prepared to handle non-routine maintenance issues for a variety of facilities.

- Maintain primarily large facilities, except for those requiring corrective action.
- Private LID facilities requiring corrective action may require a jurisdiction to hire a private party or use their own staff to complete the work. Property owners should be billed for these expenses.

4. Inspections

Regular and appropriately timed inspections are necessary for the proper operation of LID facilities over the full life cycle of the installation. Inspectors should be trained in the design and proper function and appearance of LID practices. Inspections should be seasonally timed in order to have early detection, repair and efficiency. These inspections should include the following: during Fall to clear debris and organic material from structures and prepare for impending storms; early winter storm events to confirm proper flow control operation and to identify any erosion problems; before major horticultural cycles (i.e., prior to weed varieties dispersing seeds); and any other regularly scheduled maintenance activities. To ensure continuity and to better identify trends in the function of facilities, the same individual(s) should inspect the same drainage area. Finally, LID facilities are integrated into the development landscape and willing homeowners can provide frequent inspection and identification of basic problems with minimal training.

Green Stormwater Operations and Maintenance Manual

Seattle Public Utilities

August 2009

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I. Overview

This manual is a summary of *routine* maintenance activities for the design of Natural Drainage System (NDS) Projects. Several *non-routine* maintenance activities are also included within this chart. The manual is divided into four service levels for the vegetation section and three service levels for the hardscape and Infrastructure section. For some design elements, the service levels are very similar.

This chart is intended to be a Maintenance Manual for scheduling and performing maintenance activities. The manual features images and descriptions for vegetation, hardscape, infrastructure, and infiltration rates. It includes NDS sites used currently in Seattle and several images from NDS projects in other municipalities. It is important to realize that *no single project includes every design element*. (That is, all the NDS portrayed in this chart will *NOT* be found within a given NDS project.) Maintenance crew coordinators need to use the relevant maintenance categories for a given project per the NDS Service Agreement.

II. How to Use This Manual

The successful use of this manual hinges on the inspection of project features, which in turn triggers the appropriate maintenance activities. To use this chart first select the desired Service Level for maintenance on an existing NDS project, then maintenance crews will inspect the system for the conditions listed in the left-hand column of the chart. Note that the desired service level may vary from project to project, based on the NDS goals, the project location, the project age (i.e. whether or not the plants have successfully established), and economic considerations. The descriptions and images for each service level may be used to help determine by visual inspection whether recommended maintenance activities, in the right-hand column, will need to be performed.

III. Contacts

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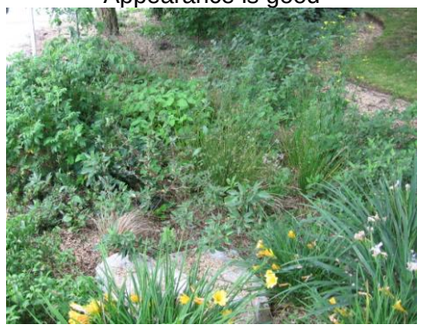
Table I. Landscape and Vegetation Manual

Service Category	Service Level A (Excellent Effort)	Service Level B (Good Effort)	Service Level C (Moderate Effort)	Service D (Poor Effort)

Aesthetics (vegetation and trash)	• **Vegetation**
	  • Healthy and attractive
	  • No bare spots
	  • Plant palette is working for facility
	  • At least 95% survival of establishing plants
	• **Weeds -** Little or no weeds are present
	• **Asthetics**
	  • Clean, distinct edges
	  • Vegetation confined to planted areas
	  • No overgrown appearance/dead growth
	• **Mulch**
	  • Evenly distributed & approximately 4” of arborist woodchip mulch. No evidence of erosion (stabilized surfaces)
	  • Limited shoulder compaction
	• Homeowner is fully maintaining (where applicable)
		• **Vegetation**
		  • Healthy with a good appearance
		  • Occasional bare spots
		  • Plant palette is mostly working for facility (At least 75%)
		• **Weeds -** Small quantities of weeds are present
		• **Asthetics**
		  • Loose edges: grass/mulch encroaching on swale or vice versa
		  • Some vegetation overlapping into pedestrian areas
		  • Overgrown in isolated areas with some dead material
		• **Mulch**
		  • 2”-4” layer of mulch is present
		  • Erosion likely unless maintenance improved
		  • Some shoulder compaction
		• Homeowner is providing some maintenance (where applicable)
		• Able to achieve Level A without complete retrofit
			• **Vegetation**
			  • Poor vegetation health and appearance
			  • Bare spots are frequent
			  • Plant palette is not working for facility (75%-50%)
			• **Weeds -** Weeds common
			• **Asthetics**
			  • No edges;
			  • Surrounding vegetation spills into swale and pedestrian areas
			• **Mulch**
			  • Mulch is less than 2”
			  • Substantial eroded areas
			  • Shoulder compaction
			• Homeowner is not maintaining swale (where applicable)
			• Unable to achieve higher service levels without complete retrofit
				• **Vegetation**
				  • Poor Planted vegetation health and appearance
				  • Bare spots are common
				  • Plant palette has failed Less than 50%
				• **Weeds** - Weeds dominant
				• **Asthetics**
				  • No edges; surrounding vegetation spills into swale or vice versa
				• **Mulch**
				  • Mulch is absent
				  • Substantial eroded areas
				  • Shoulder compaction
				• Homeowner is not maintaining swale (where applicable)
				• Unable to achieve higher service levels without complete retrofit

Service Category	Service Level A (Excellent Effort)	Service Level B (Good Effort)	Service Level C (Moderate Effort)	Service D (Poor Effort)
Special Considerations for Noxious Weeds	Zero tolerance of Class A, B, C and non-designated noxious weeds	Zero tolerance of Class A and B. Class C weeds are controlled or absent. Non-designated weeds are controlled or absent.	Zero tolerance of Class A weeds. Class B and C are controlled. Non-designated are present (Control Prog. Is minimal)	Zero tolerance of Class A weeds. Class B, C, and Non-Designated are largely uncontrolled except for public safety reasons (illegal dumping, obstructs vision)
	Link to King County Noxious Weed List			
Vegetation	Lush vegetation; excellent appearance 	Mostly healthy vegetation with good appearance 	Mostly healthy vegetation with neglected appearance 	Poorly planted vegetation health and neglected appearance 

Service Category	Service Level A (Excellent Effort)	Service Level B (Good Effort)	Service Level C (Moderate Effort)	Service D (Poor Effort)
Aesthetics	Healthy, well-maintained vegetation; excellent appearance 	Appearance is good 	Moderate appearance 	Poorly maintained appearance 
Mulch	Deep mulch layer(4”-6”), clean edges, limited compaction 	Some mulch(2”-4”), loose edges, some compaction 	Little mulch(Less than 2”), no defined edge, shoulder compaction 	No mulch present, no defined edge, shoulder compaction 

Service Category	Service Level A (Excellent Effort)	Service Level B (Good Effort)	Service Level C (Moderate Effort)	Service D (Poor Effort)
Weeds	No weedy species present 	Occasional weedy species (5-10%) 	Lots of Weedy species (10-20%) 	Weedy species predominant (More than 20%) 
Erosion and bare spots	No erosion or bare spots 	Some erosion and bare spots (0-5%) 	Substantial erosion and bare spots (5-10%) 	Completely eroded and bare spots(More than 10%) 

Table II. System Functionality

Service Category	Service Level A (Excellent Effort)	Service Level B (Good Effort)	Service Level C (Moderate Effort)	Service Level D (Poor Effort)
SYSTEM FUNCTIONALITY				

Bioretention (vegetation & soils/substrate)	• **Vegetation**
	  • 100% of swale bottom is covered with healthy, wetland vegetation
	  • No bare spots
	• **Infiltration**
	  • Soil is well aerated, no evidence of compaction
	  • Water drains within 48 hours
	• **Maintenance**
	  • No erosion, channelization or scouring
	  • No significant sediment or debris accumulation
		• **Vegetation**
		  • At least 80% of swale bottom is covered with healthy, wetland vegetation
		  • Minimal bare spots 10%
		• **Infiltration**
		  • Some evidence of compaction (2" of mulch)
		  • Most water drains within 24 hours, minimal long-term ponding
		• **Maintenance**
		  • Some erosion, channelization or scouring
		  • Sediment or debris accumulation does not affect the function of the facility.
			• **Vegetation**
			  • Between 60-80%of swale bottom is covered with healthy, wetland vegetation
			  • A few bare spots 10-20%
			• **Infiltration**
			  • Compacted soils (Lack of Mulch)
			  • The presence of long-term ponding (> 72 hours)
			• **Maintenance**
			  • Erosion, channelization or scouring
			  • Sediment and debris accumulations inhibit the water quality function of the facility without affecting conveyance
				• **Vegetation**
				  • Less than 60% of swale bottom is covered with healthy, wetland vegetation
				  • Many bare spots
				• **Infiltration**
				  • Compacted soils (Lack of Mulch)
				  • The presence of long-term ponding (> 72 hours)
				• **Maintenance**
				  • Erosion, channelization or scouring
				  • Sediment and debris accumulations inhibit the water quality and conveyance of the system

Biofiltration (vegetation & soils/substrate)	• **Vegetation** • At least 80% of swale bottom covered with healthy, uniformed fine-stemmed vegetation at least 18 - 24 inches high • No bare spots • **Maintenance** • No erosion, channelization or scouring • No ponding • No significant sediment or debris accumulation	• **Vegetation** • Between 60-80% of swale bottom covered with healthy, uniformed fine-stemmed vegetation at least 18 - 24 inches high • A few bare spots 10% • **Maintenance** • Some erosion, channelization or scouring • No ponding • Sediment and debris does not affect the function of the facility.	• **Vegetation** • Between 60-40% of swale bottom covered with healthy, uniformed fine-stemmed vegetation, of at least 18 -24 inches high • Many bare spots 10-30% • **Maintenance** • Erosion, channelization or scouring • The presence of ponding • Sediment and debris affect the water quality function of the facility with out affecting conveyance.	• **Vegetation** • Less than 40% of swale bottom covered with healthy, uniformed fine-stemmed vegetation, of at least 18 -24 inches high • Many bare spots • Maintenance • Erosion, channelization or scouring • The presence of ponding Sediment and debris accumulations inhibit the water quality and conveyance of the system

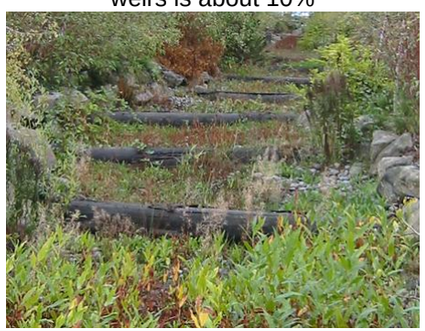
Service Category	Service Level A (Excellent Effort)	Service Level B (Good Effort)	Service Level C (Moderate Effort)	Service Level D (Poor Effort)
Bioretention + biofiltration (vegetation & soils/substrate)	• At least 100% of swale bottom is covered with healthy, uniformed fine-stemmed wetland vegetation at least 18 - 24 inches high • Soil is well aerated, no evidence of vehicle compaction • No erosion, channelization or scouring • Water drains within 24 hours • No visible bare spots • Acceptable level of sediment or debris accumulation	• 80% of swale bottom is covered with healthy, uniformed fine-stemmed wetland vegetation at least 18 - 24 inches high • Some evidence of vehicle compaction (lack of mulch) • Some erosion, channelization or scouring • Most water drains within 24 hours, minimal long-term ponding • A few bare spots 10-20% • Acceptable level of sediment or debris accumulation	• Less than 80-50% of swale bottom is covered with healthy, uniformed fine-stemmed wetland vegetation at least 18 - 24 inches high • Compacted soils • Erosion, channelization or scouring • The presence of long-term ponding (> 72 hours) • Many bare spots • Significant build up of sediment or debris	• Less than 50% of swale bottom is covered with healthy, uniformed fine-stemmed wetland vegetation at least 18 - 24 inches high • Compacted soils • Erosion, channelization or scouring • The presence of long-term ponding (> 72 hours) • Many bare spots or noxious weeds/grass • Significant build up of sediment or debris
Swale bottom vegetation				

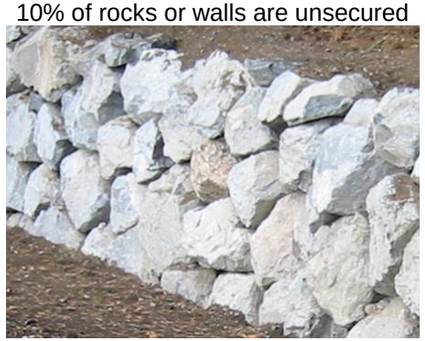
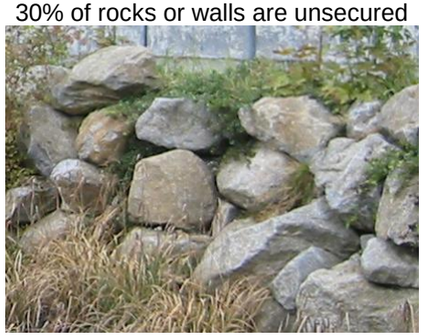
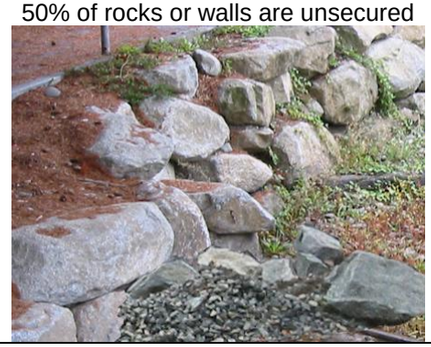
Service Category	Service Level A (Excellent Effort)	Service Level B (Good Effort)	Service Level C (Moderate Effort)	Service Level D (Poor Effort)
Sediment or debris accumulation				
Conveyance (vegetation & soils/substrate)	• Healthy vegetation • No erosion, channelization or scouring • No bare spots • No build up of sediment or debris • No non-designed obstructions to flow	• Mostly healthy vegetation • Some erosion, channelization or scouring • Minimal bare spots 10-20% • Some build up of sediment or debris • Minimal non-designed obstructions to flow (over-grown vegetation, trash rack blockages)	• Some vegetation • Erosion, channelization or scouring • Many bare spots 20-40% • Significant build up of sediment or debris • Significant non-designed obstructions to flow (over-grown vegetation, trash rack blockage)	• Poor or no vegetation • Erosion, channelization or scouring • Many bare spots 40% or more • Significant build up of sediment or debris • Significant non-designed obstructions to flow (over-grown vegetation, trash rack blockage)

Table III. Hardscape Manual

Service Category	Service Level B (Good Effort)	Service Level C (Moderate Effort)	Service Level D (Low Effort)	Recommended Maintenance Activities
HARDSCAPE & INFRA-STRUCTURE	**Summary** • sediment Is minimal • infrastructure is always accessible • no competition between roots(/dense plant material?) and pipes • no trash is present • small accumulation of organic debris on grates or screens • limited buildup of sediment behind check dams or log weirs • no erosion or undercutting surrounding weir walls • rockery and walls are stable and secure • stormwater sedimentation structures less than ½ full (NPDES)	**Summary** • some sediment is present • infrastructure is usually accessible • some competition between roots(/dense plant material?) and pipes • small amounts of trash are present • moderate accumulation of organic debris on grates or screens • occasional large sediment deposits behind check dams or log weirs • minimal erosion and/or undercutting surrounding weir walls • occasional loose rocks; walls are secure • stormwater sedimentation structures less than ½ full (NPDES)	**Summary** • Lots of sediment buildup is observed • infrastructure is mostly inaccessible • Significant competition between roots(/dense plant material?) and pipes • Trash is present • Heavy accumulations of organic debris on grates or screens • frequent large sediment deposits behind check dams or log weirs • Erosion and/or undercutting surrounding weir walls • Loose rocks; walls are not secure • stormwater sedimentation structures less than ½ full (NPDES)	
Sedimentation structures— TYPE 2	Sediment is blocking 10% of structure 	Sediment is blocking 30% of structure 	Sediment is blocking 50% of structure 	□ if sediment present, remove trash and unwanted organic debris □ muck out / vactor structure and dispose of waste properly

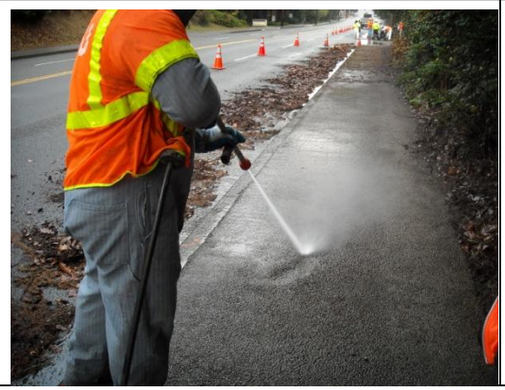
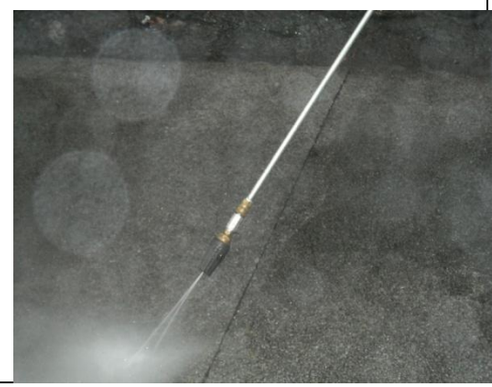
Service Category	Service Level B (Good Effort)	Service Level C (Moderate Effort)	Service Level D (Low Effort)	Recommended Maintenance Activities
Grates and debris screens on catch basins (CBs)	Accumulation of organic debris covers 10% of structure 	Accumulation of organic debris covers 30% of structure 	Accumulation of organic debris covers 50% of structure 	□ if present, muck out / vactor catch basins and dispose of waste properly. Clear debris and vegetation growth around intakes.
□ Outlet structures— TYPE 2	Accumulation of organic debris covers 10% of structure 	Accumulation of organic debris covers 30% of structure 	Accumulation of organic debris covers 50% of structure 	□ remove debris and dispose of waste properly

Service Category	Service Level B (Good Effort)	Service Level C (Moderate Effort)	Service Level D (Low Effort)	Recommended Maintenance Activities
Flow control structures and overflow structures or pipes	Accumulation of organic debris covers 10% of structure 	Accumulation of organic debris covers 30% of structure 	Accumulation of organic debris covers 50% of structure 	Remove debris and vegetation growth and dispose of waste properly
□ Log weirs and check dams	Sediment deposit of check dams or log weirs is about 10% 	Sediment deposits of check dams or log weirs is about 30% 	Sediment deposits of check dams or log weirs is about 50% or more 	□ add splash-pool (rocks) to reduce scouring of swale-bottom for undercutting or eroding □ remove sediment, debris, and trash if ponding upstream of check-dam

Service Category	Service Level B (Good Effort)	Service Level C (Moderate Effort)	Service Level D (Low Effort)	Recommended Maintenance Activities
Weir walls w/ flow control notch	Sediment deposit downstream of check dams or log weirs is about 10% 	Sediment deposit downstream of check dams or log weirs is about 30% 	Sediment deposit downstream of check dams or log weirs is about 50% or more 	add rocks to splash-pool to prevent scouring reinforce weir wall *(non-routine)*if leakage occurs at structure edges
Rockery / boulders PHOTOS TO BE UPDATED (shown here with little vegetative cover, but rocks may become covered in plant growth in well-established projects)	10% of rocks or walls are unsecured 	30% of rocks or walls are unsecured 	50% of rocks or walls are unsecured 	□ ensure large rocks and boulders are stable

Service Category	Service Level B (Good Effort)	Service Level C (Moderate Effort)	Service Level D (Low Effort)	Recommended Maintenance Activities
Manufactured block sidewalls	10% of rocks or walls are unsecured 	30% of rocks or walls are unsecured 	50% of rocks or walls are unsecured 	ensure blocks and bricks are stable
Soil-wrap walls ("green walls")	Erosion or undercutting of 10% is walls visible around rockery, walls and weirs 	Erosion or undercutting of 30% is visible around rockery, walls and weirs 	Erosion or undercutting of 50% is walls visible around rockery, walls and weirs 	□ repair as needed stabilize loose soil-bricks, notify vegetation crew if weeds present, water needed, or re-planting required

Table IV. Porous Pavement Manual

Level of Service	Service Level B (Good Effort)	Service Level C (Moderate Effort)	Service Level D (Low Effort)	Recommended Maintenance Activities
Street	Infiltration rate of 20 +in/hr	Infiltration rate of 10 in/hr	Infiltration rate of 3 in/hr	based on peak flows for 100yr design storm 3 in/hr and excess capacity for localized failure
Sidewalk	Infiltration rate of 20 +in/hr	Infiltration rate of 10 in/hr	Infiltration rate of 1 in/hr	
				Test infiltration rates per SPU Materials Lab procedure.
	Pressure wash @2500 psi bi-annually	Pressure wash @ 2500 psi annually	Pressure wash @ 2500 psi annually	
				Pressure wash pavement with an industrial machine

Level of Service	Service Level B (Good Effort)	Service Level C (Moderate Effort)	Service Level D (Low Effort)	Recommended Maintenance Activities
	Remove 100% of Garbage	Remove 75% of Garbage	Remove 20% of Garbage	
				Remove all garbage and debris as required with wire brush, broom, or pressure washer. Dispose of debris and garbage off site.
	Remove 100% vegetation growth (moss/creeping plants) adjacent to pavement	Remove 75% vegetation growth (moss/creeping plants) adjacent to pavement	Remove 40% vegetation growth (moss/creeping plants) adjacent to pavement	
				Vegetated, landscaped, eroded, or soiled areas need to be maintained to prevent growth on to porous pavement, debris clogging, and lateral transport of adjacent materials. Keep joints free of material mechanically, with a weed burner, or pressure washer.

Level of Service	Service Level B (Good Effort)	Service Level C (Moderate Effort)	Service Level D (Low Effort)	Recommended Maintenance Activities
Infiltration Failure	Any evidence ponding water needs to be reported to USM Green Stormwater Infrastructure O&M Asset Manager for monitoring and restoration. Contact: Drena Donofrio at 206-571-1566			
Misc.	Inspect pavement for spalling, cracking edges, pot holes, depressions, large cracks, skid resistance, and raveling concrete 2X per year.	Inspect pavement for spalling, cracking edges, pot holes, depressions, large cracks, skid resistance, and raveling concrete 1X per year.	Inspect pavement for spalling, cracking edges, pot holes, depressions, large cracks, skid resistance, and raveling concrete every other year.	*SPU Materials lab (to quantify variability in field testing)*
	Pavement condition survey every 2 years	Pavement condition survey every 3 years	Pavement condition survey every 7 years	SDOT - contact Ben Hansen or current manager
	Address all safety issue to SDOT			Contact 684-ROAD for repair.

Table V. Other Elements

Service Category	Service Level B (Good Effort)	Service Level C (Moderate Effort)	Service Level D (Low Effort)	Recommended Maintenance Activities
OTHER ELEMENTS	• up to 10% blockage caused by organic matter, sediment, debris or trash • irrigation system functions properly with no blockages or breaks in drip system • ponding only to intended depth (varies by location) • pond capacity is maintained • no liner leakages reported	• between 10-30% blockage caused by organic matter, sediment, debris or trash • irrigation system functions properly with no blockages or breaks in drip system • ponding only to intended depth (varies by location) • some sediment may reduce pond capacity • no liner leakages reported	• more than 30% blockage caused by organic matter, sediment, debris or trash • irrigation system has occasional blockages or breaks in drip lines • ponding only to intended depth (varies by location) • sediment buildup causes reduced pond capacity • no leakages reported	
□ Curb cuts	Curb is up to 10% blocked 	Curb is between 10-40% blocked 	Curb is above 40% blocked 	□ remove trash and organic debris and dispose properly

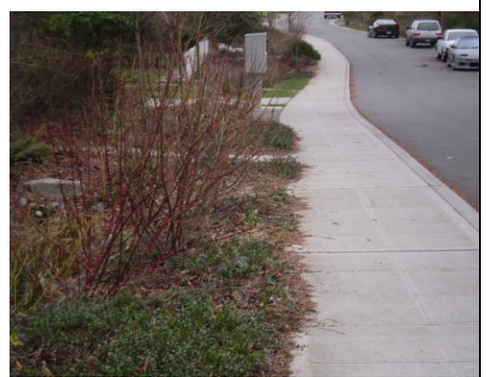
Service Category	Service Level B (Good Effort)	Service Level C (Moderate Effort)	Service Level D (Low Effort)	Recommended Maintenance Activities
Culverts	Culvert is up to 10% blocked 	Culvert is between 10-40% blocked 	Culvert is more than 40% blocked 	remove trash and organic debris and dispose properly
□ Irrigation systems (for establishing vegetation)	holes in drip irrigation correspond with plant locations; nozzles have no breaks, leaks, or blocks 	plants and drip holes mostly aligned minimal seeping of water when system is off; no breaks or blockages 	system has breaks or leaks; vegetation is not being adequately watered; complaints of ponding 	repair as needed (for establishing vegetation 0-3 years old)

Service Category	Service Level B (Good Effort)	Service Level C (Moderate Effort)	Service Level D (Low Effort)	Recommended Maintenance Activities
Porous/pervious pavers	water infiltrates well, pavers are up to 10% clogged or minimal ponding is observed 	water infiltrates well, pavers are between 10-40% clogged and minimal ponding is observed 	water does not infiltrate well, pavers are more than 40% clogged 	vactor debris, weed burn as required

Table VI. Infiltration

Infiltration Failure	Any evidence of a cell holding water for more than 24 hours needs to be reported to USM Green Stormwater Operations and Maintenance Asset Manager for monitoring or retrofitting. Contact: Drena Donofrio at 206-571-1566

Table VII. Safety, Spill Prevention and Response, and Pest Control

Service Category	Service Level A (Excellent Effort)	Service Level B (Good Effort)	Service Level C (Moderate Effort)	Service Level D (Low Effort)
SAFETY, MOBILITY, ACCESS	• Vegetation causes no visibility (line of sight) or driver safety issues • Infrastructure is always accessible and has clear access path • Vegetation around infrastructure is maintained at height to prevent damage during routine maintenance • Fire hydrant access clearly visible and accessible • Vegetation does not impede pedestrian access	• Vegetation causes minimal visibility (line of sight) or driver safety issues • Infrastructure is mostly accessible and has access path • Most vegetation around infrastructure is maintained at height to prevent damage during routine maintenance • Fire hydrant access clearly visible and accessible • Vegetation does not impede pedestrian access	• Vegetation causes visibility (line of sight) or driver safety issues • Infrastructure is not accessible and has clear access path • Vegetation around infrastructure is will be damaged during routine maintenance • Fire hydrant access clearly visible and accessible • Vegetation does not impede pedestrian access	• Vegetation causes visibility (line of sight) or driver safety issues • Infrastructure is not accessible and has clear access path • Vegetation around infrastructure is will be damaged during routine maintenance • Fire hydrant access clearly visible and accessible • Vegetation does not impede pedestrian access
				
SPILL PREVENTION	• Exercise spill prevention measures whenever handling or storing potential contaminants. • Fertilizers, Herbicides, Fungicides and Insecticides are prohibited in GSI.			

SPILL RESPONSE	• Clean up spills as soon as possible to prevent contamination of stormwater.
PEST CONTROL	Insects: • Standing water remains in the basin for time periods suitable to insect development. • Identify the cause of the standing water and take appropriate actions to address the problem. Rodents: • Rodent holes are present near the facility. • Fill and compact soil around the holes.

Seattle Public Utilities

Seattle Public Utilities
Seattle Municipal Tower
700 Fifth Avenue
Suite 4900
PO Box 34018
Seattle, WA 98124-4018

APPENDIX 5: STREET TREE LIST

The following list provides information on the growth patterns and favorable site characteristics for trees that are appropriate in the street landscape. Bioretention cells and swales located along streets may have specific soil and moisture conditions that differ from conventional roadside planting areas. Trees in this list may be applicable in bioretention areas depending on the physical setting and project objectives. See Appendix 3 for trees specifically recommended in bioretention cells or swales.

Local jurisdictions often have specific guidelines for the types and location of trees planted along public streets or rights-of-way. The extent and growth pattern of the root structure must be considered when trees are planted in bioretention areas or other stormwater facilities with under-drain structures or near paved areas such as driveways, sidewalks or streets. The City of Seattle, for example, has the following requirements for tree planting location:

- 3½ feet back from the face of the curb
- 5 feet from underground utility lines
- 10-15 feet from power poles
- 7½ - 10 feet from driveways
- 20 feet from street lights or other existing trees
- 30 feet from street intersections
- Planting strips for trees should be at least 5 feet wide

Trees included in the "small" tree section of this list typically remain at or below a 30-foot mature height, which is compatible (unless indicated otherwise) with clearances for most overhead utility/electrical lines. Some jurisdictions may not recommend planting street trees that are fruit bearing or are otherwise "messy". Contact local authorities to determine if there are guidelines or restrictions to consider when making tree selections in your area.

Minimum ranges for planting strip widths are included and are compiled from various local and regional jurisdiction recommendations. Generally, larger planting widths are recommended for optimal tree health and longevity. Under certain circumstances the use of root barriers or root guards may assist in preventing or delaying damage to adjacent paved surfaces. Consult a certified arborist for specifications and information on root barriers and installation.

Note on Conifers: Often jurisdictions recommend very large planting areas for conifers due to potential visibility or safety issues associated with lower limbs. If properly trimmed and maintained, however, conifers can be incorporated safely into the urban streetscape and provide excellent year-round interception of precipitation.

indicates a tree that does well in wet areas
* denotes native species

SMALL TREES (under 30 feet in height)
Space evenly every 20 to 30 feet

SPECIES/COMMON NAME	EXPOSURE	MATURE HT./SPREAD	PLANTING STRIP WIDTH	COMMENTS
Acer campestre Hedge maple	Sun/partial shade	To 30 feet/ To 30 ft. spread	4-5 feet	Deciduous; prefers moist, rich soils; slow growing tree tolerant of air pollution and soil compaction; yellow fall color; cultivars available including Queen Elizabeth maple ('Evelyn') with dark green, glossy foliage
*Acer circinatum** Vine maple	Sun/partial shade	20-25 feet/ 10 ft. spread	8 feet	Deciduous; prefers moist, well-drained soils; tolerates seasonal saturation and varying soil types; drought tolerant once established; bushy shrub or small tree; most often multi-trunked and does well in small groups; white flowers April-June; orange and red fall color
Acer ginnala Amur maple	Sun/partial shade	To 20 feet/ 20 ft. spread	4 feet	Deciduous; prefers moist, well-drained soils, but is tolerant of drought; is often multi-trunked, but can be pruned to a single stem; rounded form; fragrant, yellowish-white flowers in spring; cultivars are available such as 'Flame' and 'Embers' with differing fall colors
Acer griseum Paperbark maple	Sun/partial shade	15-25 feet/ 15-25 ft. spread	4 feet	Deciduous; prefers moist, well-drained soils, but is moderately drought tolerant; bronze peeling bark provides year-round visual interest; often multi-trunked, but can be trained to a single stem; scarlet fall color; slow growing; disease and pest resistant
Acer palmatum Japanese maple	Partial shade/Sun	15-25 feet/ 10-25 ft. spread	4 feet +	Prefers moist, well-drained soils; deciduous; slow to moderate growth rate; multi-trunked with spreading branches; intolerant of inundation but moderately drought resistant; vibrant fall colors; many cultivars available including 'Emperor I', 'Katsura', and 'Osakazuki'

SPECIES/COMMON NAME	EXPOSURE	MATURE HT./SPREAD	PLANTING STRIP WIDTH	COMMENTS
Acer platanoides 'Globosum' Globe Norway maple	Sun/partial shade	15-20 feet/ 15-20 ft. spread	4-5 feet +	Moist soils preferred, but tolerates drought and seasonal inundation; tolerant of urban pollution; dense, compact, round form; slow-growing deciduous tree with brilliant fall color; shallow root system may make mowing under the tree slightly difficult; good selection for locations under power lines; another cultivar well suited for such a location is *A. platanoides* 'Almira,' reaching only 20-25 ft.
Acer triflorum Roughbark maple	Sun/partial shade	25-30 feet/ 20-25 ft. spread	Check with jurisdiction	Deciduous; prefers moist soils, but somewhat drought tolerant once established; apricot and gold fall color; rough, knobby trunk provides interest in winter; disease and pest resistant; non-aggressive roots do not damage sidewalks or driveways
Acer truncatum Purpleblow maple	Sun	20-25 feet/ 20-25 ft. spread	5 feet	Prefers moist, well-drained soil, but drought tolerant; very cold hardy deciduous tree; moderate growth rate; yellow flowers in spring; an additional maple cultivar of interest is 'Pacific sunset'
Amelanchier x *grandiflora* 'Autumn Brilliance' Serviceberry	Sun/partial shade	20-25 feet/ To 15 ft. spread	4 feet +	Moist to dry, well-drained soils; shrub or small tree; drought tolerant; white clustered flowers in spring; red or yellow fall color; also try 'Princess Diana' for bright red fall color and the slightly taller 'Robin Hill' (20-30 feet)
Carpinus caroliniana American hornbeam	Sun/partial shade	20-30 feet/ 20-30 ft. spread	4-6 feet	Deciduous; prefers moist, rich soils; grows near saturated areas but is only weakly tolerant of saturation; blooms March-May; slow growing; deep coarse laterally spreading roots; medium life span; also consider *Carpinus japonica* (Japanese hornbeam)

SPECIES/COMMON NAME	EXPOSURE	MATURE HT./SPREAD	PLANTING STRIP WIDTH	COMMENTS
Cercis Canadensis Eastern redbud	Partial shade/sun	25 feet/ 30 ft. spread	4 feet +	Deciduous; prefers moist, rich soils; tolerant of shade; somewhat drought resistant, but not in full sun; purple-lavender flowers; medium longevity; often multi-trunked; shallow, fibrous roots become deeper on drier sites; fairly short-lived; blooms March-May
Cornus kousa var. 'Chinensis' Chinese kousa dogwood	Sun/partial shade	To 20 feet/ To 20 ft. spread	3 feet +	Prefers moist soils; tolerant of varying soil types; moderate growth rate; deciduous; white flowers in June and large red fruits that resemble a raspberry in September; red to maroon fall color; more disease resistant than other dogwoods; many additional cultivars available
Crataegus x *lavalii* Lavalle hawthorn	Sun	To 25 feet/ 15-20 ft. spread	4-5 feet	Deciduous; prefers moist, well-drained soil, but tolerant of varying soil types; bronze and coppery red fall color; white flowers in spring; fruit can be a bit messy
Malus ssp. Flowering crabapple	Sun/partial shade	15-25 feet/ 6-15 ft. spread	4-5 feet	Tolerant of prolonged soil saturation; somewhat untidy; short lived; tolerant of drought and seasonally saturated soils; deciduous; white or faintly pink flowers in spring; numerous *Malus* species and cultivars provide a variety of foliage and flower colors, forms, and fruit. Many cultivars and varieties available including *M.* 'Adirondack' (to 10 ft. height), *M. floribunda* (Showy crab); *M.* 'Sugar Tyme' (to 18 ft. height); native *M. fusca** (Pacific crabapple) reaches 30-40 ft in height
Parrotia persica Persian ironwood	Sun/light shade	15-35 feet/ 15-30 ft. spread	4 feet	Moist to dry soils; drought tolerant when established, deciduous tree with moderate growth rate; brilliant fall color; often multi-trunked, but can be trained to have just one; tolerates urban pollution and soil compaction; surface roots do not generally cause problems; virtually disease and pest-free

SPECIES/COMMON NAME	EXPOSURE	MATURE HT./ SPREAD	PLANTING STRIP WIDTH	COMMENTS
Prunus serrulata 'Shirofugen' Japanese flowering cherry	Sun	To 25 feet/ To 25 ft. spread	4 feet	Deciduous flowering tree; moist, well-drained soils; double pink to white blooms in spring; vigorous grower; additional desirable choices include *P. serrulata* 'Snowgoose', 'Kwanzan', and 'Shirotae'
Quercus ilex Holly oak	Sun/partial shade	20+ feet/ 20 ft. spread	5 feet +	Prefers moist soils, but grows in varying soils; hearty, slow-growing evergreen tree; light pink flowers May-June; pruning will keep tree small for a hedge, without pruning may grow considerably larger – not appropriate under utility lines; tolerates salt water spray

MEDIUM TREES (30-50 feet in height)
Space evenly every 25 to 35 feet

SPECIES/COMMON NAME	EXPOSURE	MATURE HT./SPREAD	PLANTING STRIP WIDTH	COMMENTS
Acer platanoides 'Columnare' Columnare Norway maple	Sun/partial shade	40-50 feet/ 15-20 ft. spread	5-6 feet	Deciduous; adapts to varying soils; upright or columnar in form making this cultivar a better choice for narrow locations; tolerant of drought and seasonal inundation; tolerates urban pollution and displays brilliant fall color; shallow rooting necessitates locating at least 4-6 feet from sidewalks and driveways to prevent heaving of pavement
Acer rubrum Red maple	Sun/partial shade	35-50 feet/ 15-40 ft. spread	5-6 feet	Deciduous tree known for fall color; prefer wet or moist soils; tolerant of summer drought and urban pollutants; fast growing with roots that may heave sidewalks or interfere with mowing; many cultivars of varying heights available including: *A. rubrum,* 'Armstrong,' Bowhall', Karpick,' 'Scarsen,' and 'Red Sunset'
Carpinus betulus European hornbeam	Sun/shade	40-60 feet/ 30-40 ft. spread	5 feet	Deciduous tree; tolerant of urban pollution and poor soils; can also be used as a hedge or screen cultivars available and suggested include 'Fasigiata' (30-40 ft. height) and 'Franz Fontaine' (30-35 ft height)
Fraxinus americana 'Autumn Applause' Ash	Sun	To 40 feet/ 25 ft. spread	5-6 feet	Deciduous; prefers moist, well-drained soils; dense, wide spreading canopy; long-lived; purple fall color; moderate growth rate; also try *F. Americana* 'Junginger'
Fraxinus oxycarpa Raywood ash	Sun	25-50 feet/ 25 ft. spread	5 feet +	Deciduous; drought and variable soil tolerant; can take extreme temperatures; does not tolerate constant wind or fog; resists pests and disease better than do other ashes; inconspicuous flowers in spring

Species/Common Name	Exposure	Mature Ht./Spread	Planting Strip Width	Comments
Fraxinus pennsylvanica Green ash/red ash	Sun	To 50 feet/ To 40 ft spread	4-5 feet +	Deciduous; prefers moist soils; fast growth rate; tolerant of wind, salt, seasonal drought and urban pollution; numerous cultivars including Patmore' (50-60 ft. height), 'Summit' (to 45 ft. height), and 'Urbanite' (to 50 ft. height)
Ginkgo biloba 'Autumn Gold' Maidenhair tree	Partial sun/partial shade	25-50 feet/ 25-30 ft. spread	5-6 feet	Moist soils; deciduous ornamental tree; fast growing and long-lived; tolerant of urban pollution, summer drought and winter inundation; showy fall color; grows in soils of varying quality; provides dense canopy; additional cultivars available
Gleditsia triacanthos inermis 'Shademaster' Thornless honeylocust	Sun/partial shade	To 45 feet/ 35 ft. spread	5-6 feet	Deciduous; prefers moist, rich soils, but will grow in varying soil types; a thornless cultivar tolerant of drought and seasonal inundation; adapts to urban pollution and displays vigorous growth; deciduous tree with showy yellow fall color; additional cultivars available such as 'Imperial,' which grows 30-35 feet, 'Moraine,' and 'Rubylace'
Koelreuteria paniculata Goldenrain tree	Sun/partial sun	20-35 feet/ 10-30 ft. spread	4 feet +	Deciduous; prefers moist well-drained soils, but is tolerant of poor soils; medium rate of growth and longevity; tolerant of periods of drought and seasonal inundation; tolerates urban pollution; provides a dense, wide-spreading canopy
Platanus x *acerifolia* 'Liberty' London planetree	Sun	To 50 feet/ 45 ft. spread	8 feet	Prefers moist, rich soils, but tolerant of a variety of soils; tolerant of seasonal drought and inundation, urban pollution and poor soils; deciduous tree resistant to sycamore anthracnose, powdery mildew, and inward spread of wood decay due to trunk wounds; patchy ornamental bark; pruning of lower branches may be required for visibility; shallow roots can cause uplifting of sidewalks and pavement – use care when locating near pavement; also try 'Bloodgood' and 'Yarwood'

SPECIES/COMMON NAME	EXPOSURE	MATURE HT./SPREAD	PLANTING STRIP WIDTH	COMMENTS
Pyrus calleryana 'Chanticleer' Flowering pear	Sun	To 40 feet/ 15 ft. spread	4-5 feet	Deciduous tree that grows well in a variety of soil types; orange to reddish fall color; white flowers in spring; additional cultivars of interest include *P. calleryana* 'Redspire' and 'Aristocrat'
Tilia cordata Littleleaf linden	Sun	30-50 feet/ 30 ft. spread	5-6 feet	Deciduous; prefers moist, well-drained soils, but tolerant of a variety of soil types; tolerant of wind and urban pollution; fast growing and long-lived; tolerates summer drought and seasonal inundation; provides a dense canopy; *C. cordata* is the hardiest linden; many forms available including, *T. cordata* 'Chancellor', 'Corzam', and 'Greenspire'

LARGE TREES (50 feet+ in height)
Space evenly every 35 to 45 feet

SPECIES/COMMON NAME	EXPOSURE	MATURE HT./SPREAD	PLANTING STRIP WIDTH	COMMENTS
*Abies grandis** Grand Fir	Sun/partial shade	100 feet/ 40 ft. spread	Check with jurisdiction	Evergreen; tolerant of fluctuating water tables and floods; medium rate of growth; root structure depends on site conditions – shallow in moist areas, deep taproot in drier conditions
Acer platanoides 'Emerald Queen' Emerald Queen Norway maple	Sun/partial shade	To 50 feet/ 40 ft. spread	5-8 feet	Deciduous; fast growing with an erect, spreading form; prefers moist soils, but is tolerant of summer drought and seasonal inundation; tolerates urban pollution; avoid locating near structures due to shallow, vigorous rooting; additional cultivars available including *A. platanoids* 'Parkway'
Acer pseudoplatanus Sycamore maple	Sun/partial shade	40-60 feet/ 25-40 ft. spread	5-8 feet	Deciduous; prefers moist, well-drained soils but is adaptable to may soil types; tolerates summer drought and seasonal inundation; tolerant of urban pollution with a moderate growth rate; sturdy, resistant to wind and salt spray; a number of cultivars are available including: *A. pseudoplatanus* 'Atropurpureum,' ' Brilliantissimum,' 'Cox' (Lustre), and 'Puget Pink'
Acer saccharum Sugar maple		60-75 feet/ 35 ft. spread	6 feet +	Deciduous; prefers moderately moist, well-drained soils; long-lived and tolerant of urban pollutants; slow to medium growth rate; needs large planting area; yellow and orange fall color; a variety of cultivars available including *A. saccharum* 'Legacy'
*Calocedrus decurrens** Incense cedar	Sun/partial shade	75-90 feet/ 10-20 ft. spread	Check with jurisdiction	Evergreen; tolerant of poor soils; drought tolerant after established; tolerant of wind and urban conditions; narrow growth habit makes this a good choice for smaller spaces and ideal for screening, fragrant tree; slow growing and long-lived

Species/Common Name	Exposure	Mature Ht./Spread	Planting Strip Width	Comments
Cedrus deodara Deodar cedar		40-60 feet/ 20-40 ft. spread	Check with jurisdiction	Evergreen; prefers moist, well-drained soils, but drought tolerant when established; fairly fast growing and long-lived; dense, wide spreading canopy; attractive cultivars available
*Fraxinus latifolia**  Oregon ash	Sun/partial shade	40-80 feet/ 30 ft. spread	6 feet +	Deciduous; saturated, ponded or moist soils; flood tolerant; small green-white flowers; tolerant of poor soils
Gleditsia triacanthos inermis Thornless honeylocust	Sun/partial shade	60-70 feet/ 40 ft. spread	5-6 feet	Deciduous; prefers moist soils, but will grow in poor soils; tolerant of drought, seasonal inundation, and urban pollution; occasionally fruit pods can create litter during winter months; thornless; cultivars available (see *G. triacanthos inermis* 'Shademaster' below in Medium trees)
Metasequoia glyptostroboides Dawn redwood	Sun	70-100 feet/ 25 ft. spread	5 feet +	Deciduous; prefers moist, deep, well-drained soils, but tolerates compacted and poor soils; long-lived, fast growing conifer; tolerant of seasonal inundation and drought; can grow in standing water; needles turn russet in the fall; needs large growing area; lower growing cultivars available such as *M. glyptostroboides* 'Gold Rush' and 'Sheridan Spire'
Picea omorika Serbian spruce	Sun/partial shade	50-60 feet/ 20-25 ft. spread	Check with jurisdiction	Slow growing; tolerant of varying soils and urban pollution; moderately drought tolerant once established; elegant evergreen spruce, good for narrow locations; lower growing cultivars available
*Pseudotsuga menziesii** Douglas fir	Sun to shade	75-120 feet/ 40 ft. spread	Check with jurisdiction	Evergreen conifer; moist to dry soils; long-lived with a medium to fast rate of growth; tolerant of summer drought, winter inundation, and poor soils; withstands wind and urban pollution; provides a nice canopy, but potential height will restrict placement

Species/Common Name	Exposure	Mature Ht./Spread	Planting Strip Width	Comments
Quercus bicolor Swamp white oak	Sun	60 feet/ 45 ft. spread	6-8 feet	Deciduous; grows in wet or moist sites, but is tolerant of drought conditions; withstands poorly drained soils; long-lived with moderate rate of growth
Quercus coccinea Scarlet oak	Sun	50-60 feet/ 45 ft. spread	6-8 feet	Deciduous; grows in a variety of soil types; long-lived with a moderate growth rate; tolerant of summer drought and urban pollution; does not tolerate saturated soils or shade; brilliant scarlet to red fall foliage
Quercus macrocarpa Burr Oak	Sun	70-80 feet/ 30-40 ft. spread	8 feet	Prefers moist soils, but is adaptable to varying soils; slow growing and long-lived; rugged looking deciduous tree; tolerant of seasonal drought and inundation; tolerates urban pollution and city conditions; provides a wide-spreading, dense canopy
Quercus phellos Willow oak	Sun/partial shade	60-70 feet/ 50 ft. spread	6 feet	Deciduous; prefers moist, well-drained soils, but grows in a wide range of soils types; long-lived tree with moderate growth rate and fibrous root system; tolerant of seasonal drought and inundation, as well as urban pollution; provides a wide-spreading, dense canopy; small delicate leaves
Quercus robur English oak	Sun	40-60+ feet/ 40 ft. spread	4-8 feet	Prefers well-drained soil; slow to moderate growth rate; long-lived deciduous tree; tolerant of seasonal drought and inundation; tolerates urban pollution, poor soils and constrained root space; susceptible to powdery mildew; many varieties and cultivars available including: 'Concordia,' 'Fastigiata,' 'Foliis Variegatis, and 'Westminster Globe.'
Quercus rubra Northern red oak	Sun/partial shade	60-75 feet/ 50 ft. spread	6-8 feet	Prefers moist, well-drained soils, but drought tolerant when established; tolerates seasonal inundation, urban pollution and salt spray; moderate rate of growth and longevity; provides a dense, wide-spreading canopy; susceptible to oak wilt fungus

Species/Common Name	Exposure	Mature Ht./Spread	Planting Strip Width	Comments
Quercus shumardii Shumard's oak	Sun	To 70 feet/ 50 ft. spread	8 feet	Prefers moist, well-drained soils; deciduous, long-lived tree; tolerant of seasonal drought and inundation, urban pollution and poor soils
Taxodium distichum Bald cypress	Sun/partial shade	To 75 feet/ 40 ft. spread	Check with jurisdiction	Deciduous conifer; wet, mucky soils; tolerant of summer drought and seasonal flooding; will grow in poor soils; slow growing; long-lived with a wide-spreading canopy; roots do not appear to lift sidewalks as readily as other species; prune lower branches for sight-lines; cultivars include *T. distichum* 'Shawnee Brave'
*Thuja plicata** Western red cedar	Partial shade/shade	200 + feet/ 60 ft. spread	Check with jurisdiction	Moist to swampy soils; evergreen tree tolerant of seasonal flooding and saturated soils; a good tree for screening; long-lived; cultivars 'Pumilio' and 'Cuprea' are shorter versions, 'Aurea' and 'Atrovirens' have distinctive foliage
Tilia platyphyllos Bigleaf linden	Sun	60-80 feet/ 60 ft. spread	Check with jurisdiction	Prefers moist, well-drained soils, but grows in a variety of soil types; deciduous tree with medium growth rate; long-lived; tolerant of seasonal drought and inundation; tolerates urban pollutants; provides a wide-spreading, dense canopy; yellowish-white flowers attract bees
Ulmus ssp. Elm hybrids	Sun	50-60 feet/ 35-50 ft. spread	6-8 feet	Deciduous; prefers moist, well-drained soils, but drought tolerant; rapid grower; attractive yellow fall color; a hybrid elm resistant to Dutch elm disease; suggested hybrids include 'Accolade', 'Homestead' and 'Pioneer'
Umbellularia californica Oregon myrtle	Sun/partial shade	40-75+ feet/ To 50 ft. spread	Check with jurisdiction	Prefers moist, well-drained soils; slow growing evergreen tree with aromatic leaves; tolerates seasonal drought and inundation; tolerant of urban pollution; provides a wide-spreading, dense canopy; resistant to pests and disease; good for tall hedges or, when trunks are thinned, as a street tree; requires summer watering until established

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